Quality Roughage for Dairy Cattle

By S. T. Slack

New York State College of Agriculture CORNELL EXTENSION BULLETIN 994

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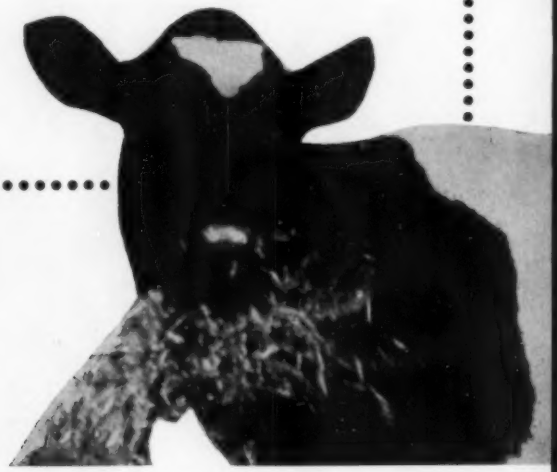


Modern livestock production revolves around growing and efficiently using farm-produced forages. The place of forages in the farm management scheme, in good land-use practices, and in land conservation is established beyond doubt. Forages grown on well-managed land can be made to yield large amounts of essential feed nutrients comparable to those of other crops and at lower cost. On the other hand, poorly managed forage crops can be low-yielding and expensive feeds. In addition, time of harvesting and methods of handling and storage are as important as yield in providing palatable forages for livestock feeding.

Dairy farming predominates in New York agriculture because large acreages of land are suited to forage crops. Of the cropland planted to harvested crops, approximately 67 percent is devoted to forage crops, either as hay or silage. Forage crop acreage and the percentage each is of the total are shown in table 1. The yield and quality of the harvested forage from these acres will vary from farm to farm.

Dairy cattle, by virtue of their unique digestive systems, are able to consume and utilize large quantities of forage. More than 70 percent of their feed comes from forages including pasture. However, more of this low cost feed could be used to reduce the cost of milk production.

In order to use more forage crops in milk production, higher yields of good quality forage are necessary. Herein lie many of the problems in a good roughage program. Experience has shown that producing forages of high quality and high feeding value year after year is one of the most difficult jobs on the farm. In the determination of quality and feeding value, the variety of forage is not so important as the stage of maturity at harvesting, the weather, and the methods used in curing and storing. Late cutting and weather damage cause the greatest losses of nutrients in hay crops. Weather damage is a greater hazard with early cutting than with late cutting. Labor and machinery necessary to process forage crops rapidly are often lacking or seemingly too expensive.

Table 1. Cropland in Forage Crops[1]

Crops	Acres	Percent
Clover & Timothy hay	1,534,818	46
Alfalfa hay	905,814	27
Other hay	349,820	10
Small grains for hay	37,712	1
Grass silage	138,057	4
Corn Silage	396,046	12
Total	3,362,267	100

[1]U. S. Department of Commerce, Bureau of Census, 1959 Census of Agriculture for the State of New York preliminary.

Top Quality Roughages for Dairy Cattle Feeding

The composition and feeding value of forage crops depends on four important points:

1. Legume or non-legume content.
2. Cutting date.
3. Digestible dry matter.
4. Crude fiber content.

Effect of cutting date

The cutting date ranks first as an influence on composition. The stage of maturity has a marked effect on the percentage of digestible protein, as shown in table 2.

As the protein content decreases, the fiber content increases. From June 1 to July 15, the fiber content increases from about 27 percent to approximately 38 percent. When this occurs, digestible energy values decline because the feeding value deposited in fiber is not easily digested. Legumes and non-legumes are similar in digestible nutrient content during different stages of development. Digestibility of early-harvested roughages is very high, about 63 percent, but, as the cutting date is delayed, digestibility declines rapidly to approximately 44 percent at maturity.

The rate at which a cow will eat roughages, commonly referred to as palatability, is as important as total digestible nutrients. Early-harvested forages with good color, leaf content and aroma are more palatable than late-harvested forages. Figure 1 indicates the rate of consumption at different stages of maturity.

Table 2. Digestible Nutrients, Digestible Protein, and Total Protein Contents of Roughages[1]

Cutting date	Approximate stage of growth	Non-legumes			Legumes		
		TDN	Dig. prot.	Total prot.	TDN	Dig. prot.	Total prot.
		%	%	%	%	%	%
June 1	Vegetative	63	12.2	15.2	63	16.8	21.0
June 15	Bud	57	9.0	11.3	57	13.1	16.4
July 1	Bloom	50	6.0	7.5	50	9.2	11.5
July 15	Mature	44	3.3	4.1	44	5.8	7.3
Second cutting 5-9 week regrowth period		52	9.0	11.3	52	12.9	16.1

[1] Reid, Cornell University, Hoard's Dairyman, June 1955

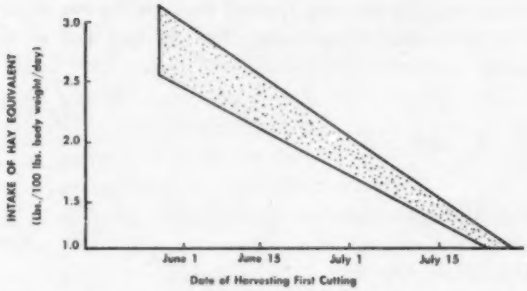


Figure 1. Influence of date of harvesting upon intake of roughage by cows fed 1 pound of grain per 3 to 3½ pounds of milk[1]

[1] Reid, Cornell University, Hoard's Dairyman, June 1955

An early cutting date, therefore, has two important influences on forages: (1) increased nutrient content per unit of dry matter, and (2) increased palatability or rate of consumption.

Handling forages as silage

Grass silage can be used advantageously as a means of obtaining high quality forage for feeding. Grass silage can be harvested early regardless of weather conditions, except in fields that are poorly drained or during prolonged rainy periods. The choice of either direct-cut or pickup-attachment machinery makes possible two types of grass silage.

Harvesting with direct-cut machinery results in a high moisture forage that causes considerable seepage from the silo. Considerable research has been conducted on methods of preventing excessive seepage, mainly through the use of preservatives. None of the preservatives saved enough nutrients to justify the cost involved, but with certain mixtures or legume and grass species, they added materially to the aroma of the silage.

With pickup-attachment machinery, the crop is generally wilted. Wilting will reduce the seepage loss from the silo. Also, it concentrates the sugars in the forage which aid in the fermentation process.

The main difficulty in using the wilting method is the determination of the moisture content. The approximate moisture level of chopped forage can be determined by means of the grab-test, with a little practice. This test consists of compressing chopped forage tightly into a ball between the hands for 20 to 30 seconds and then releasing the pressure suddenly. Fine-chopped forage

should be used in making the test, that is, it would be equivalent to a cutter setting of $\frac{1}{4}$ inch or $\frac{3}{8}$ inch. The condition of the ball and the corresponding moisture levels are as follows:

Condition of forage ball	Approximate range in moisture content
	percent
When ball holds its shape and there is considerable free juice	Over 75
When the ball holds its shape but there is very little free juice	70 to 75
When the ball falls apart slowly and there is no free juice	60 to 70
When the ball falls apart rapidly	Below 60

A 65 - 70 percent moisture content is considered to be the most satisfactory level for making wilted silage. Some dairymen fill the lower two-thirds of their

Table 3. Dry Matter Losses in Grass Silage

Treatment	Hay crops	Total dry matter loss as percent of stored materials
Molasses 60 lbs./Ton[1]	Direct cut 1st yr. clover and timothy	21.3
Molasses 80 lbs./Ton[1]	Direct cut 2nd yr. clover and timothy	16.9
No preservative[2]	Direct cut 1st yr. clover and timothy	29.2
Molasses 70 lbs./Ton[2]	Direct cut 1st yr. clover and timothy	28.0
Brewers grains 100 lbs./Ton[2]	Direct cut 1st yr. clover and timothy	25.5
Sodium metabisulfate 8 lbs./Ton[2]	Direct cut 1st yr. clover and timothy	27.4
No preservative[3]	Wilted, alfalfa-timothy mixture	16.8
No preservative[4]	Wilted, 2nd yr. clover and timothy	21.0

[1] Cornell University Agricultural Experiment Station, Bul. 910, 1955
[2] Cornell University Agricultural Experiment Station, Bul. 912, 1955
[3] U. S. Department of Agriculture Tech. Bul. 1079, 1954
[4] Cornell University Agricultural Experiment Station, Bul. 874, 1951

silo with 60 to 70 percent moisture forage and finish off with direct cut material. They have found that they get better packing with the wetter material on top and that the excess juice will be absorbed in the lower part of the silo.

In addition to seepage losses, the process of changing certain fermentable carbohydrates to acids which preserve the silage causes a considerable loss of dry matter. This loss cannot be materially reduced by preservatives or wilting. Also, top and side spoilage results in a loss of dry matter.

Total losses of dry matter from field to feeding may amount to 20 to 30 percent of the original crop. A summary of these losses, as determined by various experiments, is given in table 3.

While the silage method seems to be a practical way to preserve nutrients in forages, the total losses of dry matter under the best of conditions will average 15 to 20 percent. It appears that care in field operations to prevent wastage, wilting to 65 percent moisture, and the prevention of excessive top and side spoilage are factors which keep these losses at a minimum.

Handling forages as dry hay

Considerable acreage of hay meadows will continue to be handled each year as field cured hay. However, greater numbers of forced-air drying installations both of natural air and of heated air are appearing on New York farms. Forced-air drying of forage can be accomplished earlier in the season with less interference from unfavorable weather.

The primary advantages of a forced-air method of handling dry forages are that it permits early cutting and reduces the loss of dry matter resulting from leaf shatter and rain damage as shown in table 4.

Heated air driers are used when large tonnages of hay are processed in a short period of time and in areas of high humidity and adverse curing condi-

Table 4. Dry Matter Losses in Hay Making

Treatment	Field loss	Storage loss	Total dry matter loss as a percent of original crop
	%	%	%
Field-cured hay (no rain)[1]	17.0	7.0	24.0
Barn-dried hay [1]	9.0	6.0	15.0
Field-cured hay (no rain)[2]	—	—	21.0
Barn-dried hay[2]	—	—	19.0
Barn-dried hay (heat)[2]	—	—	15.0

[1] Cornell University Agricultural Experiment Station Bul. 874, 1951
[2] U. S. Department of Agriculture, Tech. Bul. 1079, 1954

tions. A dairyman with 200 tons of hay or more to process each season might well afford a heat-drier despite the extra cost per ton of hay. Drier equipment, housing, fuel, and labor in rehandling the hay are the major cost items. In addition to the advantages gained with an unheated air system, heat drying results in haying over a shorter period of time because of less time lost from adverse weather conditions.

Hay conditioners

Hay processing machinery referred to as crushers and crimpers have been designed to crack the stems of the forage plant causing the pithy inner portions to cure more rapidly than the intact stem. This process speeds the rate of curing with a greater saving of leaves and thereby improves the quality of hay. The rate of drying will depend on the density of swath, temperature and humidity. Curing time may be decreased by a half to a full day or more in many cases. These machines supplement the processing of hay for mow or heat-drying and are of particular value in the field-curing procedure.

Chopping hay

During recent years, the use of field choppers or forage harvesters for handling hay from the windrow has greatly increased. When used with suitable equipment for hauling and unloading the chopped hay, the amount of labor required per ton is very low. The cost per ton is reduced materially when a forage harvester is used not only to handle the hay, but also to handle hay crops or corn for silage.

The chopper should be set to chop the hay as long as possible since long hay is more palatable to cattle than finely chopped hay. For safe storage, chopped hay must be a little drier than is necessary with long or baled hay. It has a greater tendency to heat unduly, because it packs much more densely and there is less opportunity for moisture and heat to escape. The chopped hay should be approximately 30 percent moisture when stored on a mow drying system and approximately 20 percent moisture for field-cured chopped hay. The hay should be distributed in the mow by adjusting the blower and should never be tramped or packed.

Chopped hay is convenient to feed provided the storage area is so located that the material can be dropped to the barn floor and fed in open mangers.

Handling corn as silage

In contrast to forage crops, corn for silage should not be harvested at too early a stage of maturity. Harvesting too early means a great sacrifice in poten-

tial yield of dry matter and feeding value. Harvesting at a far-advanced stage, however, does not solve the problem of satisfactory silage making, because corn silage ensiled at a stage when the dry-matter content is high is likely to mold. Corn makes the best silage if cut when the kernels have passed the dough stage and reached the glazing stage, but while most of the leaves are still green. At the glazing stage, the dent varieties will be well dented. The corn crop stores much of its highest quality nutrients during the late stages of growth. Ensiling should not be delayed longer, or the corn will become too mature to make the most palatable and nutritious silage.

Comparative Feeding Value of Forages

There is plenty of experimental evidence to show that the method of harvesting or storing the crop as silage, field-cured hay or barn-dried hay has no influence on the nutritive value of the nutrients preserved when the forage is cut at the same time. Adverse weather conditions or a considerable loss of leaves will, however, decrease the nutritive value. Leaching and rain damage also reduce palatability with resulting lowered milk production.

Table 5 shows the comparative feeding value of forages harvested at the same time by different methods.

However, when the hay crop is handled at different times or stages of maturity, as would normally be the case, considerable differences are apparent in feeding value as indicated by the comparison in tables 6 and 7.

Table 5. Daily consumption and milk production for roughages harvested at the same time (same stage of maturity) by different methods[1]

Roughage	No. of cows	Roughage Consumption		Dry matter intake from roughage	Daily grain intake	Daily 4% fat-corrected milk production
		Hay	Hay-crop silage			
		Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Barn-dried hay	63	30.0	None	27.1	9.8	31.5
Field-cured hay	63	30.5	None	27.4	9.8	31.1
Barn-dried hay	27	28.3*	None	24.4	10.5	31.2
Field-cured hay	27	27.4*	None	24.5	10.5	30.6
Hay-crop silage	27	6.0*	53.4	23.1	10.5	31.9

* Includes 6 pounds of second cutting mixed hay fed daily to all cows to supplement the silage and other hays.

[1] Cornell University, Agricultural Experiment Station Bul. 874, 1951

Table 6. Daily Consumpion and milk production for roughages harvested at different dates or stages of maturity by different methods[1] (Short-time experiment, same levels of grain.)

Date of cutting	Roughage	Daily Feed Consumption Actual	Dry matter	Daily grain fed	Daily 4% FCM	Relative milk per acre
		Lbs.	Lbs.	Lbs.	Lbs.	%
June 1, 7	Early silage	115.6	27.3	11.5	44.7	123
June 18, 15	Barn-dried hay	30.5	26.1	11.5	40.0	127
July 10, 5	Field-cured hay	28.6	24.4	11.5	37.6	100
July 10, 5	Late silage	87.4	24.1	11.5	38.1	101

[1] Cornell University Agricultural Experiment Station Bul. 910, 1955

Table 7. Daily consumption and milk production of roughages harvested at different dates or stages of maturity by different methods[1] (Long-time experiment, different levels of grain.)

Date of cutting	Roughage	Rate of grain	Daily grain fed	Daily Feed Consumption Actual	Dry matter	Daily 4% FCM
			Lbs.	Lbs.	Lbs.	Lbs.
June 3-10	Early silage	1:4	13.2	103.6	24.9	50.4
		1:8	5.7	114.7	27.7	45.8
June 3-10	Early barn-dried hay	1:4	11.9	31.7	27.5	44.0
		1:8	5.4	37.2	32.3	39.5
July 3-10	Late field-cured hay	1:4	9.2	28.2	24.5	34.6
		1:8	3.9	29.0	25.1	29.9

[1] Cornell University Agricultural Experiment Station Bul. 957, 1960

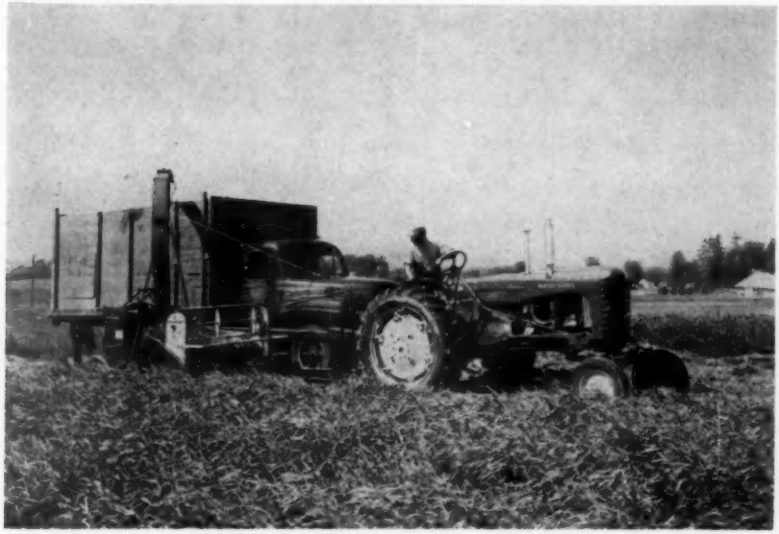
Summary of Forage Research

1. Early cutting is the most important single factor in obtaining high feeding value in harvested forage crops because of:
   (a) Greater palatability
   (b) Higher digestibility
   (c) Significant increases in milk production
2. Barn drying and making of silage both permit early cutting and provide procedures for "beating" the weather.
   (a) Advantages over field curing are in saving of nutrients, with barn-dried hay usually having an advantage over ensiling.
   (b) Both should be used primarily as "insurance" methods.
3. There is no "best" forage harvesting pattern that suits every farm. Patterns need to be worked out for each farm that will enable early cutting and the use of storage methods that keep nutrient losses to a minimum. Flexibility is essential.

Figure 2. (above) Just right—early cut forage with timothy heads just emerging from the boot and legumes in the pre-bloom stage for best feeding value.

Figure 3. Too old—late cut with timothy heads in full bloom and legumes in post bloom stage, all too advanced for high feeding value.

Figure 4. Silage making using direct-cut forage harvester



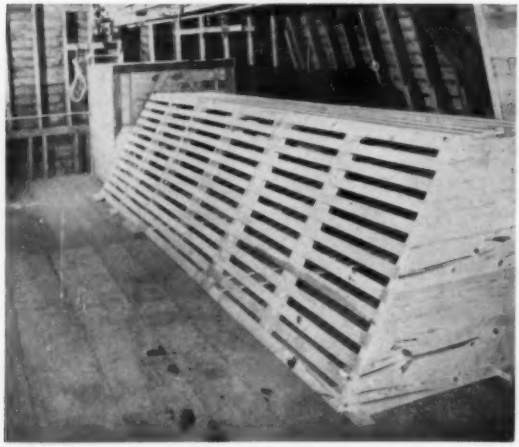


Figure 5. Forced-air ventilating system for barn drying using a modified "A" frame

How to Make Maximum Use of Available Roughages in Dairy Cattle Feeding

In order to make maximum use of roughage, cows should have all the high-quality palatable forage they can eat daily. It is necessary, therefore, to adjust either the supply of roughages or the number of animals in order to feed each animal all the roughage it can consume. Adjusting cow numbers is not easily done.

An inventory of roughages will indicate the status of the supply for feeding. The following inventory form is useful for this purpose.

Roughage	Tons	Multiply tons by	Hay equivalent tons
Hay			
Good		1.0	
Fair		.8	
Poor		.6	
Corn silage		.33	
Grass silage		.33	
Straw		.5	
Corn stover (chopped)		.6	

Total tons hay equivalent available _____.

Number	Average weight per head	Total live weight	Divide total live-weight by 1000 and multiply by:	Tons of hay equiv. needed
_____cows			3	
_____heifers			3	

Total tons of hay equivalent needed _____.

The difference between the forage supply and forage need indicates whether the supply is adequate or a shortage exists. In case of an adequate supply, full use or liberal feeding of roughage is possible. With a shortage, either a reduced feeding rate or the purchase of roughage is necessary. In cases of a short supply of roughages, dairymen can afford to pay approximately ½ to ⅔ the price of a ton of grain for good hay (table 7). Care should be taken, however, to determine the date of harvesting, content of legumes, leafiness and brightness in any purchased hay.

Excellent quality hay—Legume, mixed, or grass hay cut at ¼ bloom, or grasses in the before-heading stage, leafy, green color and free from mold and mustiness.

Good quality hay—Legume, mixed, or grass hay cut at ½ bloom, or grasses in the early-heading stage, leafy, green color and free from mold and mustiness.

Fair quality hay—Legume, mixed, or grass hay cut at full bloom, stemmy, and lacking green color.

Poor quality hay—Any hay cut after full bloom, hays severely weather damaged, bleached, stemmy, lacking leaves, moldy and musty.

Table 7. Per ton value of hay in relation to grain.

	Price of Grain per Ton					
	$50	$60	$70	$80	$90	$100
	Value of hay per ton					
Excellent	33	40	46	53	59	66
Good	30	36	42	48	54	60
Fair	25	30	35	40	45	50
Poor	20	24	28	32	36	40

Three steps to maximum use of roughages

Step 1.—Make a good appraisal of the quality or nutrient content of the roughage that is being fed. Does it have the power to produce milk? An excellent guide to the nutrient content of hay and grass silage was suggested in the chart on date of cutting as it affects roughage composition (page 4).

Step 2.—Determine the rate of roughage consumption for the herd. This can best be done by weighing the various roughages fed in a day's time and deducting the wastage. Once a month is often enough to check the rate of roughage consumption unless major changes in hay and silage feeding occur.

Next, the weight of the different roughages fed should be converted into the equivalent of good hay, using conversion factors in table 8.

For example, three tons of grass silage would equal one ton of good hay, and/or one ton of fair hay will equal 1600 pounds of good hay. By these calculations the herd's roughage intake can be converted into a common figure or good hay equivalent.

By dividing the number of cows into the total good hay equivalent, the consumption rate of the average cow is determined. The average 1000 pound cow, with heavy roughage feeding, may be consuming roughage at the rate of 30 pounds daily, or at the rate of 3 pounds per 100 pounds of liveweight. However, if only 20 pounds of good hay equivalent was consumed daily by the average 1000 pound cow, the rate would be only 2 pounds per 100 pounds of liveweight, or a moderate rate of roughage feeding. A rate less than 2 pounds of roughage consumption per 100 pounds of liveweight is considered a light rate of feeding.

Step 3—Weigh each cow's milk at least once a month. This is done through a testing program, but other dairymen can accomplish the same thing by doing it themselves. A butterfat test is desirable but not essential in determining the rate of grain feeding.

Table 8. Conversion factors for Converting Feeds into Equivalent Amounts of Good Hay

Feed	Remarks	Conversion factor
Good hay	Early-cut without more than ordinary loss of leaves	1.00
Fair hay	Late-cut without excessive weather damage or loss of leaves	.80
Poor hay	Late-cut, coarse, stemmy and unpalatable	.60
Grass silage	Early-cut without moldiness	.33
Corn silage	Cut at dent stage	.33

Quality of Hay Plus Consumption Rate Plus Milk Produced Determines Amount and Kind of Grain Fed

Kind of grain to feed

There is no best combination of grains for dairy cattle feeding. Each concentrate mixture will vary with the supply of home-grown grains, the price of by-product ingredients, and their availability. The important factor is that the concentrate mixture must supplement the roughage protein, total digestible nutrients, minerals and vitamins, rather than replace them, to obtain a balanced daily ration.

Provided cows are fed sufficient feed, roughages plus grain, to meet their requirements for total digestibile nutrients, the levels of crude protein indicated in table 9 are high enough to balance the roughage protein.

Table 9. Protein Content of Grain Mixtures

Kind of Roughage	Consumption Rate		
	High	Medium	Low
	Total Protein		
	%	%	%
Non-legume hay and/or			
grass silage	18	16	14
corn silage	20	18	16
Mixed hay and/or			
grass silage	16	14	12
corn silage	18	16	14
Legume hay and/or			
grass silage	12	12	12
corn silage	14	12	12

Palatable combinations of grains and by-products feeds can be mixed in the proportions shown in table 10 to obtain the desired protein content.

Table 10. Suggested Concentrate Mixtures

Feeds	Pounds per ton				
	14%	16%	18%	20%	24%
Corn	700	600	500	400	200
Oats	560	460	360	360	260
Molasses	100	100	100	100	100
Wheat bran	300	300	300	300	300
Distillers' dried grains (corn)	200	300	500	500	600
Soybean or Linseed oil meal	100	200	200	300	500
Iodized salt	20	20	20	20	20
Dicalcium phosphate	20	20	20	20	20

Amount of grain to feed

Grain should be added to the ration to get extra milk insofar as it is economical and does not materially reduce roughage consumption. Each cow should be fed grain on the basis or her individual requirements. It is very wasteful of concentrates and uneconomical to feed all cows the same amount of grain. Recommendations for grain feeding which do not take into consideration the quality of roughages, rate of roughage consumption, amount of milk produced, stage of lactation and body condition of the cow are not good guides to follow. While many guides for grain feeding are useful, it remains the good judgment or art of the dairyman to get the best results from grain feeding. Table 11 presents a guide to grain feeding rates with various rates of roughage consumption.

Table 11. Grain Feeding Schedule

Rate of Roughage Consumption—pounds hay equivalent per 100 pounds liveweight	Feed 1 pound of grain for each 2½ pounds of milk above the amount given below		Feed 1 pound of grain for each 2 pounds of milk above the amount given below	
	Holstein	Ayrshires Brown Swiss	Guernsey	Jersey
Heavy (2½ pounds or greater)	20	18	15	12
Moderate (2 pounds)	12	10	8	6
Light (1½ pounds or less)	0	0	0	0

Cows that have freshened recently should receive a more liberal amount of grain than indicated by the above table. Cows in this stage of lactation can and will respond to the added grain. Also, a dry cow shold be fed enough grain to provide her with good body condition.

An Extension publication of the
New York State College of Agriculture,
a unit of the State University,
at Cornell University
Ithaca, New York

Revised January 1961

Cooperative Extension Service, New York State College of Agriculture at Cornell University and the U. S. Department of Agriculture cooperating. In furtherance of Acts of Congress May 8, June 30, 1914. M. C. Bond, Director of Extension, Ithaca, New York.

PS-10M